CLAIMS

We claim:

1. A method for simultaneous removal of hydrogen sulfide or other sulfur-containing compounds and mercury from a gas stream which comprises the step of:

   a. contacting the gas stream containing hydrogen sulfide or other sulfur-containing compounds and mercury with a mixed metal oxide catalyst at a temperature equal to or less than about 400°C in the presence of oxygen such that a substantial amount of the hydrogen sulfide or other sulfur-containing compounds present in the gas stream is oxidized to sulfur; and

   b. condensing the sulfur out of the gas stream whereby mercuric sulfide formed by interaction of the sulfur generated with mercury in the gas stream is also condensed with the sulfur,

   wherein the mixed metal oxide catalyst comprises a low oxidation activity metal oxide and one or more higher oxidation activity metal oxides.

2. The method of claim 1 wherein the low oxidation activity metal oxide is titania, silica, alumina or mixtures thereof.

3. The method of claim 1 wherein the gas stream comprises hydrocarbons, oxygenated hydrocarbons, sulfur-containing hydrocarbons, aromatic hydrocarbons, aliphatic hydrocarbons, hydrogen, carbon monoxide or mixtures thereof.

4. The method of claim 1 wherein the gas stream comprises hydrogen, carbon monoxide or mixtures thereof.

5. The method of claim 1 wherein the gas stream comprises hydrocarbons.

6. The method of claim 1 wherein the gas stream comprises methane.

7. The method of claim 1 wherein the gas stream is a natural gas stream or a synthesis gas stream.

8. The method of claim 1 wherein the gas stream comprises aromatic hydrocarbons.

9. The method of claim 1 wherein the temperature at which the catalyst is contacted with the gas stream in the presence of oxygen is less than 400°C.

10. The method of claim 9 wherein the temperature is between about 160°C and about 250°C.

11. The method of claim 9 wherein the temperature is between about 170°C and about 200°C.

12. The method of claim 1 wherein 85% by volume or more of the hydrogen sulfide or other sufur-containing compounds in the gas stream is converted to sulfur, or a mixture of sulfur and sulfur dioxide.

13. The method of claim 1 wherein the hydrogen sulfide in the gas stream is converted substantially to sulfur.

14. The method of claim 1 wherein the low oxidation activity metal oxide is titania or a mixture of titania with silica.

15. The method of claim 1 wherein the low oxidation activity metal oxide is titania.

16. The method of claims 1 wherein the low oxidation activity metal oxide is an alumina.

17. The method of claim 16 wherein the alumina is alpha alumina or gamma alumina.

18. The method of claim 1 wherein the low oxidation activity metal oxide is selected from titania, silica, alumina or mixtures thereof and the higher activity metal oxide is selected

from an oxide of a metal selected from the group V, Cr, Mn, Fe, Co, Ni, Cu, Nb, Mo, Tc, Ru, Rh, Hf, Ta, W, Au, La, Ce, Pr, Nd, Pm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu and mixtures thereof.

19. The method of claim 18 wherein the higher oxidation activity metal oxide is selected from a metal oxide of a metal selected from the group consisting of Fe, Co, Mn, Cr, Cu, Mo, Nb, or mixtures thereof.

20. The method of claim 18 wherein the higher oxidation activity metal oxide is a metal oxide of a transition metal or a mixture of transition metals.

21. The method of claim 18 wherein the mixed metal oxide catalyst comprises one or more metal oxides of lanthanide metals.

22. The method of claim 1 wherein the mixed metal oxide catalyst comprises titania, silica, alumina or mixtures thereof in combination with one or more metal oxides of a metal selected from Fe, Co, Mn, Cr, Cu, Mo, Nb and mixtures thereof.

23. The method of claim 1 wherein the mixed metal oxide catalyst comprises titania, silica, alumina or mixtures thereof in combination with two or more metal oxides of a metal selected from Fe, Co, Mn, Cr, Cu, Mo and Nb.

24. The method of claim 1 wherein the mixed metal oxide catalyst comprises titania, silica, alumina, or mixtures thereof in combination with three or more metal oxides of a metal selected from Fe, Co, Mn, Cr, Cu, Mo and Nb.

25. The method of claim 1 wherein the mixed metal oxide catalyst comprises titania, silica, alumina or mixtures thereof in combination with a metal oxide of Mo, Nb or both and in combination with a metal oxide selected from Fe, Co, Mn, Cr, and Cu.

26. The method of claim 1 wherein the mixed metal oxide catalyst comprises titania, an oxide of Mo, an oxide of Nb and an oxide of one or more of Fe, Co, Cr, Mn and Cu.

27. The method of claim 1 wherein the metal oxide catalyst comprises titania, an oxide of Mo, an oxide of Nb and an oxide of Cu or Fe.

28. The method of claim 1 wherein titania or a combination of titania and silica is present at a level of 50% by weight or more in the catalyst.

29. The method of claim 28 wherein titania or a combination of titania and silica is present at a level of 85% by weight or more in the catalyst.

30. The method of claim 1 wherein the metal oxide catalyst contains from about 0.1% to about 10% by weight of each of one, two, three or four metal oxides wherein the metal oxide is a metal oxide wherein the metal is selected from Fe, Co, Mn, Cr, Cu, Mo and Nb.

31. The method of claim 1 wherein the metal oxide catalyst contains from 0.1% to about 10% by weight of oxide of Mo, an oxide of Nb or both and contains from about 1% to about 10% by weight of an oxide of Fe, Cu or Co.

32. The method of claim 1 wherein the catalyst comprises about 1 to about 10% by weight copper oxide, about 1 to about 10% by weight niobium oxide, about 0.1 to about 1% by weight molybdenum oxide with the remainder being titania or a mixture of titania and silica.

33. The method of claim 1 wherein the catalyst comprises about 1 to about 10% by weight iron oxide, about 1 to about 10% by weight niobium oxide, about 0.1 to about 1% by weight molybdenum oxide with the remainder being titania or a mixture of titania and silica.

34. The method of claim 1 wherein the catalyst comprises about 1 to about 10% by weight cobalt oxide, about 1 to about 10% by weight niobium oxide, about 0.1 to about 1% by

weight molybdenum oxide with the remainder being titania or a mixture of titania and silica.

35. The method of claim 1 wherein the mixed metal oxide catalyst comprises about 0.4 to about 0.6% by weight molybdenum oxide, about 4 to about 6% by weight niobium oxide, about 4 to about 6% by weight of copper oxide, cobalt oxide, iron oxide, or a mixture thereof with the remainder being titania or a mixture of titania and silica.

36. The method of claim 1 wherein the mixed metal oxide catalyst comprises up to about 10% by weight of a binder.

37. The method of claim 36 wherein the binder is silica.

38. The method of claim 1 wherein the mixed metal oxide catalyst comprises titania in combination with one or more mixed metal oxides wherein the metal is selected from Fe, Cu, Co, Mo, Nb, Mn and Cr and wherein the temperature at which step a is conducted ranges between about 160°C to about 250°C.

39. The method of claim 1 wherein the catalyst is co-formed.

40. The method of claim 1 wherein the catalyst is formed into pellets or is extruded.

41. The method of claim 1 wherein the catalyst has a surface area ranging from about 50 to about 150 m^2/g.

42. The method of claim 1 wherein the catalyst is sulfated on contact with hydrogen sulfide, sulfur dioxide or sulfur.

43. The method of claim 1 wherein the catalyst is prepared by calcining a mixed metal oxide powder at a temperature of about 300°C to 550°C.

44. The method of claim 1 wherein the catalyst is prepared by calcining a mixed metal oxide powder at a temperature of about 400°C to 450°C.

45. The method of claim 1 further comprising the step of adding hydrogen sulfide to the gas stream prior to contacting the gas stream with the mixed metal oxide catalyst wherein the amount of hydrogen sulfide added to the gas stream is sufficient to generate a hydrogen sufide concentration in the gas stream such that sulfur is generated on oxidation.

46. The method of claim 1 further comprising the steps of:

c. optionally returning the product gas stream from which sulfur and mercury have been condensed to step a to generate additional sulfur,or a mixture of sulfur and sulfur dioxide and repeating step b and c until the undesired mercury, hydrogen sulfide or both are removed from the gas stream.

47. The method of claim 1 where in step a the temperature of operation, catalyst and the O_2/H_2S ratio in the feed gas stream are selected to generate a product gas stream in which sulfur generated by H_2S oxidation is maximized and SO_2 generated by H_2S oxidation is minimized.

48. The method of claim 47 which further comprises the step, after condensation of sulfur and mercuric sulfide, of treating the gas stream with a liquid redox process for removal of remaining undesired H_2S.

49. The method of claim 47 which further comprises the step, after condensation of sulfur and mercuric sulfide, of treating the gas stream with a biological sulfur removal process for removal of remaining undesired H_2S.

50. The method of claim 47 which further comprises the step, after condensation of sulfur and mercuric sulfide, of treating the gas stream with a scavenger process for removal of remaining H_2S.

51. The process of claim 47 which further comprises the step, after condensation of sulfur and mercuric sulfide, of treating the gas stream with an amine separation unit to separate H_2S, SO_2 or both from the product gas to generate a feed gas stream containing H_2S, SO_2 or both which is thereafter returned to step a.

52. The process of claim 47 wherein the gas stream is a natural gas stream containing H_2S.

53. The process of claim 47 wherein the gas stream is a synthesis gas stream containing H_2S.